West coast of Newfoundland capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) larval survey, part 1: Description of the data collected in partnership with the industry (Barry Group) in July 2004

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2005

WEST COAST OF NEWFOUNDLAND CAPELIN (*Mallotus villosus* M.) AND ATLANTIC HERRING (*Clupea harengus harengus* L.) LARVAL SURVEY, PART 1: DESCRIPTION OF THE DATA COLLECTED IN PARTNERSHIP WITH THE INDUSTRY (BARRY GROUP) IN JULY 2004

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ABSTRACT

Grégoire, F., W. Barry, J. Barry, L. Lefebvre, C. Lévesque, and J. Hudon. 2005. West coast of Newfoundland capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) larval survey, part 1: Description of the data collected in partnership with the industry (Barry Group) in July 2004. Can. Data Rep. Fish. Aquat. Sci. 1168: vi + 32 p.

In partnership with the Barry Group in Corner Brook, a larval survey was conducted from July 15 to 17, 2004, between Bonne Bay and Port au Port Bay on the west coast of Newfoundland. Fish eggs and larvae were found at all the sampled stations. The two most abundant groups of eggs that were identified were CYT (cunner [*Tautogolabrus adspersus*] and yellowtail flounder [*Limanda ferruginea*]), and CHW (cod [*Gadus morhua*], haddock [*Melanogrammus aeglefinus*], and witch flounder [*Glyptocephalus cynoglossus*]). Mackerel eggs (*Scomber scombrus* L.) were also found at most of the stations. Of the twenty species of larvae identified, the most notable were those of capelin (*Mallotus villosus* M.), herring (*Clupea harengus harengus* L.), cod, righteye flounder (Pleuronectidae spp.), and cunner. Depth-based profiles of water temperature and salinity were made for each station. All the biological and oceanographic data collected during the survey were compiled and are presented in the tables, figures, and appendices found in this document. These data will be analyzed and published in a second report.

RÉSUMÉ

Grégoire, F., W. Barry, J. Barry, L. Lefebvre, C. Lévesque, et J. Hudon. 2005. West coast of Newfoundland capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) larval survey, part 1: Description of the data collected in partnership with the industry (Barry Group) in July 2004. Can. Data Rep. Fish. Aquat. Sci. 1168: vi + 32 p.

En partenariat avec le Groupe Barry de Corner Brook, un relevé larvaire a été réalisé du 15 au 17 juillet 2004 entre les baies de Bonne Bay et de Port au Port de la côte ouest de Terre-Neuve. Des œufs et des larves de poissons ont été retrouvés à toutes les stations échantillonnées. Les deux plus abondants groupes d'œufs qui ont été identifiés sont CYT (tanche-tautogue [*Tautogolabrus adspersus*] et limande à queue jaune [*Limanda ferruginea*]) et CHW (morue [*Gadus morhua*], aiglefin [*Melanogrammus aeglefinus*] et plie grise [*Glyptocephalus cynoglossus*]). Des œufs de maquereau (*Scomber scombrus* L.) ont aussi été retrouvés à la plupart des stations. Des vingt espèces de larves identifiées, les plus importantes sont celles du capelan (*Mallotus villosus* M.), du hareng (*Clupea harengus harengus* L.), de la morue, des pleuronectidés (Pleuronectidae spp.) et de la tanche-tautogue. Des profils de la température et de la salinité de l'eau en fonction de la profondeur ont été réalisés à chaque station. Toutes les données biologiques et océanographiques recueillies lors du relevé ont été compilées et sont présentées dans les tableaux, figures et annexes du présent document. Ces données seront analysées et publiées dans un second rapport.

INTRODUCTION

The capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) commercial fisheries are of great importance to the economy of several communities of the west coast of Newfoundland. In spite of this, there is little information on the biology and ecology of these two species. To date, the only data available come from the analysis of commercial fishery samples (Grégoire and Lefebvre, 2003; Grégoire et al., 2003a) and from by-catches in the groundfish abundance surveys that are carried out each year in the northern Gulf of St. Lawrence (Grégoire et al., 2003a, 2003b). As a whole, these data are incomplete because commercial catches are made only on the adult component of the stocks and because by-catches come from a sampling method that is not appropriate for pelagic species such as capelin and herring. Moreover, as there are no abundance surveys directed specifically on these two species, the scientific advice regarding their spawning biomass and the acceptable level of catches that are submitted to resource managers and the industry are based on non-exhaustive research (DFO, 2005a, 2005b).

The study of the first life stages of marine fish has contributed greatly to the development of the basic concepts for stock management (Rutherford, 2002). To this end, plankton surveys have been made to describe the distribution of the eggs, larvae, and juveniles of several commercial species and to calculate their abundance, mortality, and growth. Following overexploitation by fishing, the distribution and abundance of larvae measured with this type of survey have been used to describe the return of certain pelagic fish stocks, such as the Barents Sea capelin (Fossum, 1992) and the Georges Bank herring (Overholtz et al., 2004). In this latter case, the larval index of abundance is even used to calibrate a sequential population analysis. Knowledge on the abundance of eggs measured with this same type of survey has also made it possible to calculate the spawning biomass of mackerel (*Scomber scombrus* L.) in the northeast Atlantic since 1977 (ICES, 2003) and in the Gulf of St. Lawrence since 1983 (DFO, 2004).

With the financial and logistic support of the Barry Group in Corner Brook, a plankton survey was done on the west coast of Newfoundland in July 2004. The objective of this survey was to collect basic information on the distribution and abundance of capelin and herring larvae found in an active fishing area located close to the coast, between Bonne Bay and Port au Port Bay (Figure 1). This area of the west coast of Newfoundland had never before been covered by this type of survey.

This report compiles and documents the biological and oceanographic data collected during this survey. The detailed analysis of these data will be presented in a second report.

MATERIAL AND METHODS

Plankton sampling was made by a large seiner from the west coast of Newfoundland, the *Ocean Provider*. At each station, plankton was collected using a bongo sampler (Posgay and Marak, 1980). This sampler is equipped with two nets, each one having an opening of 61 cm and lined with 333-micron mesh. A General Oceanics flowmeter was placed at the opening of each net to measure the volume of water filtered. The 10-min tows were carried out following a saw-tooth

pattern (Hempel, 1973) between the surface and a maximum depth of 50 m, or to within 5 m of the bottom at shallower stations. Once on deck, the nets were raised and rinsed with seawater. The plankton sample from one of the two nets was preserved in a diluted buffered formaldehyde solution (4-5%) (Hunter, 1985) while that of the second net was placed in a concentrated ethanol solution (95%). A CTD instrument (Sea-Bird Electronics Inc.) was installed on the bongo sampler to obtain a profile of water temperature and salinity in the water column.

Plankton sorting was performed at the Fisheries and Oceans laboratory in Mont-Joli during the fall of 2004. To reduce analysis time, each sample was split using the Van Guelpen beaker technique (Van Guelpen et al., 1982). The criteria used to identify fish eggs and larvae were mainly drawn from Fritzsche (1978), Elliott and Jimenez (1981), and Fahay (1983). The total length (Hardy, 1978) of capelin and herring larvae preserved in the formaldehyde solution was measured to within 0.01 mm. The larvae preserved in ethanol can be used later in growth studies based on otolith microstructure. Ethanol is used in this kind of study because, contrary to the formaldehyde solution, it does not cause bone structure decalcification (Shields and Carlson, 1996). The results of the sorting were input to data files and validated.

RESULTS

The survey was made from July 15 to 17, 2004. A total of 39 stations were sampled in the study area (Figure 2). The positions and depths of these stations are presented in Table 1 along with the duration of each tow and the volume of water filtered. The temperature profiles for each station are shown in Appendix 1. From the CTD profiles, mean temperatures and salinities were calculated by depth intervals of 2 m from 0 m to 20 m and intervals of 5 m between 20 m and 50 m (Tables 2 and 3). Mean temperatures indicate a relative constancy in temperatures for the whole of the sampled area (Figure 3). However, starting from approximately 16 m, these temperatures fell quickly at offshore stations.

Fish eggs were found at each station (Appendix 2). The most notable groups were CYT and CHW. The CYT group is associated with the eggs of cunner (*Tautogolabrus adspersus*) and yellowtail flounder (*Limanda ferruginea*) and the CHW group with those of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and witch flounder (*Glyptocephalus cynoglossus*). Mackerel eggs (*Scomber scombrus* L.) were also found at most of the stations. The life stage of these latter was identified based on criteria presented in Girard (2000).

The larvae of twenty fish species were also found during the survey (Appendix 3). The most notable were those of capelin (*Mallotus villosus* M.), herring (*Clupea harengus harengus*), cod, righteye flounder (Pleuronectidae spp.), and cunner. The mean length of capelin larvae was 5.62 mm (n=2031) (Table 4A) and the mean length of herring larvae was 8.90 mm (n=476) (Table 4B). A main mode characterizes the length frequency distributions of these two species (Figure 4). However, the range of sizes is larger in herring.

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Table 1. Description of the stations and tows completed during the capelin and Atlantic herring larval survey of July 2004.

STATION NUMBER	DATE (yyyy-mm-dd)	TIME OF THE DAY (hh:mm) (NDT)	LATITUDE °N (degrees minutes)	LONGITUDE °W (degrees minutes)	DEPTH Station bottom (m)	DEPTH Maximum sampled (m)	TOW DURATION (mm:ss)	VOLUME OF WATER FILTERED (m^3)
1	2004-07-15	09:05	49° 09'	58° 12'	118	46	11:00	273
2	2004-07-15	09:55	49° 12'	58° 12'	112	43	10:00	231
3	2004-07-15	15:40	49° 27'	58° 12'	30	25	10:42	268
4	2004-07-15	16:19	49° 30'	58° 12'	30	28	10:39	259
5	2004-07-15	16:53	49° 33'	58° 12'	60	49	11:46	255
6	2004-07-17	11:50	49° 06'	58° 18'	70	54	11:53	332
7	2004-07-17	11:15	49° 09'	58° 18'	125	46	11:42	256
8	2004-07-17	10:35	49° 12'	58° 18'	125	51	12:50	316
9	2004-07-15	10:48	49° 15'	58° 18'	83	56	10:00	240
10	2004-07-15	13:06	49° 18'	58° 18'	25	19	10:35	274
11	2004-07-15	13:43	49° 21'	58° 18'	39	35	10:26	240
12	2004-07-15	14:19	49° 24'	58° 18'	47	45	11:50	288
13	2004-07-15	14:57	49° 27'	58° 18'	53	50	10:46	244
14	2004-07-15	20:58	49° 09'	58° 24'	50	47	11:26	395
15	2004-07-15	20:20	49° 12'	58° 24'	40	33	11:42	284
16	2004-07-15	11:32	49° 15'	58° 24'	40	38	12:00	270
17	2004-07-15	12:23	49° 18'	58° 24'	30	28	12:00	244
18	2004-07-17	09:05	49° 03'	58° 30'	48	45	11:00	279
19	2004-07-16	07:31	49° 06'	58° 30'	80	61	10:24	240
20	2004-07-16	06:51	49° 09'	58° 30'	82	53	12:18	298
21	2004-07-15	19:37	49° 12'	58° 30'	65	53	12:12	257
22	2004-07-17	06:25	48° 51'	58° 36'	45	40	10:48	175
23	2004-07-17	07:07	48° 54'	58° 36'	20	16	10:22	272
24	2004-07-17	07:46	48° 57'	58° 36'	35	31	10:27	263
25	2004-07-16	09:27	49° 00'	58° 36'	50	46	11:17	268
26	2004-07-16	08:51	49° 03'	58° 36'	48	46	10:53	252
27	2004-07-16	08:15	49° 06'	58° 36'	52	46	11:33	281
28	2004-07-16	17:36	48° 39'	58° 42'	25	23	12:04	300
29	2004-07-16	20:14	48° 45'	58° 42'	20	16	10:22	260
30	2004-07-16	13:23	48° 48'	58° 42'	15	11	10:51	244
31	2004-07-16	13:58	48° 51'	58° 42'	15	12	11:29	258
32	2004-07-16	10:56	48° 54'	58° 42'	30	22	09:46	245
33	2004-07-16	10:19	48° 57'	58° 42'	30	24	10:15	253
34	2004-07-16	18:23	48° 36'	58° 48'	15	11	10:01	256
35	2004-07-16	19:06	48° 39'	58° 48'	15	12	10:35	268
36	2004-07-16	16:38	48° 42'	58° 48'	15	13	11:25	251
37	2004-07-16	12:38	48° 48'	58° 48'	20	13	10:16	247
38	2004-07-16	11:46	48° 51'	58° 48'	42	39	10:54	249
39	2004-07-16	15:52	48° 51'	58° 54'	15	14	10:26	245

Table 2. Mean water temperature (°C) by depth interval (m) for the stations sampled during the capelin and Atlantic herring larval survey of July 2004.

DEPTH	STATION																			
(m)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0-2	N/A	14.04	13.65	14.09	13.67	13.63	N/A	13.85	13.28	13.17	13.09	13.17	N/A	N/A	13.66	N/A	13.27	N/A	N/A	13.26
2-4	13.63	13.81	13.06	13.14	12.51	13.63	13.89	13.85	13.24	12.96	12.86	12.76	12.65	14.06	13.14	13.09	13.09	N/A	13.80	13.22
4-6	13.25	13.54	12.80	12.88	12.42	13.61	13.89	13.85	13.22	12.83	12.75	12.71	12.58	13.48	13.06	13.00	12.89	13.74	13.35	12.97
6-8	13.15	13.29	12.17	12.77	12.28	13.59	13.88	13.79	13.01	12.70	12.38	12.60	12.51	13.29	12.77	12.97	12.83	13.74	12.93	12.51
8-10	12.43	11.24	11.85	12.00	10.81	13.57	13.76	13.59	12.47	12.58	12.16	12.28	12.46	13.03	12.39	12.85	12.74	13.70	12.42	11.88
10-12	12.10	9.37	11.82	9.88	9.12	13.49	13.71	13.33	12.27	12.48	12.05	11.84	12.45	12.89	12.08	12.56	12.56	13.56	12.18	10.47
12-14	11.87	8.97	10.85	7.82	7.70	13.44	13.66	12.40	12.14	12.40	11.73	10.95	12.34	12.76	11.30	11.90	12.45	13.37	11.03	8.54
14-16	10.07	8.97	9.01	6.60	6.10	13.37	13.59	10.90	11.71	12.13	11.27	10.14	11.27	12.24	10.14	11.06	12.23	13.00	8.67	7.88
16-18	8.00	8.10	8.41	5.72	5.18	13.08	13.35	9.63	11.06	10.68	10.79	9.05	8.84	11.19	9.32	10.43	12.01	12.17	7.07	7.53
18-20	7.22	7.25	7.12	5.01	5.02	12.59	12.93	9.05	9.32	9.29	10.08	8.06	7.19	7.92	8.46	9.19	11.89	11.77	6.04	7.30
20-25	6.18	6.38	5.95	4.43	4.36	11.32	11.45	7.48	7.11		8.06	6.19	5.66	6.99	6.92	6.67	10.15	10.36	5.15	6.24
25-30	4.42	4.96	5.48	4.14	3.60	8.62	7.16	5.45	5.11		5.07	4.85	4.29	6.49	4.99	4.43	6.50	7.59	4.13	4.22
30-35	3.48	3.82			2.77	5.99	4.81	4.90	4.25		4.01	3.96	3.33	6.28	3.33	3.19		5.57	3.10	3.13
35-40	2.96	3.34			1.81	3.77	3.50	3.69	2.87		3.51	2.84	2.69	5.51		3.02		4.84	2.46	2.64
40-45	2.32	2.54			1.49	2.64	2.60	2.45	2.29			2.02	2.18	3.33				3.53	2.05	1.97
45-50	2.15				1.35	1.93	2.22	1.85	1.71			1.95	2.02	2.82				3.31	1.64	1.47
50-55						1.76		1.56	1.56				2.01						1.23	1.25
55-60									1.48										0.96	

Table 2. (Continued).

DEPTH (m)	STATION 21	22*	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
0-2	13.28		N/A	N/A	13.97	13.46	12.90	14.79	15.43	13.69	13.65	N/A	13.53	14.30	14.66	15.44	13.62	13.33	15.14
2-4	12.44		13.70	13.50	13.45	13.12	12.35	14.63	14.82	13.58	13.60	13.17	13.40	14.24	14.14	15.19	13.45	13.23	14.95
4-6	12.31		13.69	13.50	12.77	12.78	12.32	14.32	14.70	13.45	13.35	13.11	13.27	13.65	13.58	15.01	13.33	13.17	13.57
6-8	12.25		13.62	13.50	12.65	12.36	12.29	14.24	14.56	13.35	13.20	13.09	13.06	12.58	13.39	14.74	13.28	13.10	12.84
8-10	12.12		13.54	13.48	12.50	11.00	12.13	13.73	14.22	13.22	13.04	13.05	12.75	11.40	12.48	14.55	13.26	12.92	10.14
10-12	11.90		13.27	13.35	10.95	8.52	10.56	13.29	13.78	12.92		13.00	11.84	9.94				12.60	9.42
12-14	10.75		12.71	13.19	8.12	7.46	9.22	11.00	13.00			12.95	9.36					11.38	
14-16	9.15		12.19	12.91	7.19	6.52	8.35	8.76				12.35	7.34					9.24	
16-18	7.65			11.89	6.72	5.45	6.76	7.97				11.06	6.12					8.82	
18-20	6.78			10.70	6.07	4.52	5.30	6.82				10.39	5.66					7.58	
20-25	5.39			9.69	5.21	3.80	4.25	6.13				10.08	5.08					5.94	
25-30	3.77			6.06	3.55	2.89	2.82											5.00	
30-35	2.42			3.88	2.49	2.64	2.26											3.09	
35-40	2.04				2.24	2.55	1.68											2.79	
40-45	1.65				2.17	2.13	1.33												
45-50	1.48					1.95	1.13												
50-55	1.51																		
55-60																			

* Not sampled

Table 3. Mean water salinity by depth interval (m) for the stations sampled during the capelin and Atlantic herring larval survey of July 2004.

DEPTH	STATION																			
(m)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0-2	N/A	29.83	31.27	31.28	31.35	31.10	N/A	30.90	31.02	31.12	31.50	31.57	N/A	N/A	31.34	N/A	30.95	N/A	N/A	31.46
2-4	30.11	30.15	31.50	31.55	31.51	31.09	31.24	30.90	31.06	31.13	31.52	31.64	31.58	31.28	31.47	31.29	30.99	N/A	31.35	31.38
4-6	30.52	30.46	31.55	31.60	31.44	31.09	31.24	30.90	31.09	31.12	31.50	31.60	31.58	31.36	31.44	31.28	31.06	31.26	31.49	31.35
6-8	30.60	30.42	31.66	31.49	31.28	31.08	31.22	30.95	31.18	31.15	31.53	31.54	31.57	31.32	31.43	31.28	31.06	31.25	31.48	31.37
8-10	31.09	30.74	31.71	31.34	31.36	31.07	31.24	31.17	31.28	31.24	31.46	31.50	31.56	31.32	31.46	31.30	31.09	31.24	31.53	31.16
10-12	31.28	31.20	31.50	31.55	31.64	31.10	31.23	31.12	31.29	31.34	31.47	31.47	31.54	31.27	31.39	31.32	31.17	31.24	31.41	31.25
12-14	31.12	31.37	31.36	31.90	31.67	31.11	31.22	31.16	31.29	31.36	31.54	31.50	31.52	31.26	31.42	31.42	31.22	31.23	31.63	31.85
14-16	31.24	31.27	31.82	31.93	31.91	31.10	31.20	31.30	31.39	31.34	31.59	31.54	31.74	31.34	31.59	31.46	31.35	31.20	32.11	31.87
16-18	31.72	31.42	31.54	31.86	32.00	31.11	31.19	31.58	31.41	31.74	31.61	31.62	31.92	31.47	31.68	31.46	31.44	31.34	31.97	31.86
18-20	31.72	31.60	31.78	32.01	31.92	31.16	31.26	31.48	31.68	31.79	31.66	31.62	31.99	32.21	31.61	31.60	31.44	31.38	31.97	31.76
20-25	31.72	31.64	31.87	31.92	31.92	31.23	31.26	31.56	31.74		31.72	31.79	31.91	31.74	31.87	31.77	31.78	31.41	31.83	31.83
25-30	31.73	31.69	31.92	31.92	31.89	31.38	31.73	31.79	31.69		31.81	31.86	31.89	31.70	31.92	31.88	32.37	31.72	31.88	32.03
30-35	31.89	31.78			31.87	31.62	31.92	31.78	31.71		31.79	31.88	31.83	31.70	32.20	31.92		31.93	31.89	32.06
35-40	31.90	31.82			32.02	31.95	32.01	31.84	31.79		32.06	32.00	31.90	31.79		31.93		31.91	31.94	32.03
40-45	31.96	31.94			32.02	32.16	32.03	31.99	31.89			32.10	31.93	32.06				32.06	31.96	32.07
45-50	31.97				32.06	32.25	32.08	32.06	31.96			32.03	31.94	31.98				32.00	32.02	32.12
50-55						32.15		32.14	32.00				31.96						32.09	32.16
55-60									32.03										32.14	

Table 3. (Continued).

DEPTH	STATION																		
(m)	21	22*	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
0-2	31.36		N/A	N/A	31.27	31.30	31.31	31.16	30.83	31.21	31.26	N/A	31.49	30.95	31.03	30.95	31.12	31.50	31.02
2-4	31.58		31.24	31.34	31.34	31.35	31.50	31.08	31.02	31.19	31.24	31.48	31.53	30.91	31.05	30.95	31.17	31.44	30.91
4-6	31.57		31.23	31.34	31.61	31.40	31.48	31.14	31.04	31.21	31.27	31.49	31.52	30.84	31.19	30.92	31.23	31.44	31.14
6-8	31.54		31.24	31.34	31.57	31.29	31.43	31.04	31.04	31.23	31.30	31.47	31.49	31.06	31.10	30.94	31.24	31.44	31.02
8-10	31.50		31.22	31.33	31.29	31.14	31.16	31.08	31.10	31.21	31.33	31.47	31.42	31.01	31.26	30.97	31.24	31.45	31.52
10-12	31.35		31.20	31.36	31.22	31.71	31.43	30.97	31.10	31.38		31.45	31.24	31.63				31.42	31.59
12-14	31.37		31.33	31.36	31.92	31.77	31.70	31.13	31.35			31.42	31.54					31.41	
14-16	31.59		31.52	31.27	32.00	31.80	31.60	31.72				31.55	31.84					31.96	
16-18	31.84			31.35	31.87	31.92	31.78	31.67				31.76	32.00					31.69	
18-20	31.86			31.57	31.96	32.06	32.06	31.82				31.65	31.99					31.85	
20-25	31.93			31.47	31.93	32.04	32.00	31.89				31.62	32.04					32.00	
25-30	31.99			31.78	32.03	32.08	32.10											31.89	
30-35	32.15			32.44	32.12	32.04	32.07											32.10	
35-40	32.10				32.06	31.98	32.10											32.03	
40-45	32.09				32.04	32.02	32.11												
45-50	32.10					32.07	32.18												
50-55	32.09																		
55-60																			

* Not sampled

Table 4. Descriptive statistics of the length measurements (mm) of capelin (A) and Atlantic herring (B) larvae sampled during the July 2004 survey.

(A)

STATION	Mean	Std. Dev.	Minimum	Maximum	Range	n
1	4.10	0.32	3.69	4.58	0.89	9
2	5.00	0.37	4.35	5.97	1.62	23
3	4.58	0.67	3.00	7.86	4.87	60
4	3.93	0.61	2.99	4.75	1.75	6
5	5.42	0.81	4.31	7.56	3.25	15
6	5.75	0.70	4.36	7.52	3.16	91
7	5.32	0.66	3.58	6.91	3.33	66
8	6.15	0.89	4.22	9.55	5.33	101
9	4.15	0.63	3.21	5.66	2.45	36
10	5.24	0.61	4.52	6.48	1.96	13
11	5.48	2.40	4.05	8.24	4.19	3
12	6.81	2.27	4.37	10.92	6.55	9
14	4.91	1.14	2.90	7.86	4.96	30
15	5.71	1.13	3.92	10.23	6.31	108
16	4.84	1.13	2.84	8.01	5.17	39
17	4.84	1.83	2.98	8.61	5.63	7
18	5.79	0.85	4.10	8.16	4.06	104
19	5.95	0.83	4.68	7.18	2.50	16
20	6.96	1.45	4.74	10.38	5.64	50
21	5.73	0.73	4.56	6.81	2.25	10
22	5.91	0.98	4.33	9.31	4.98	104
23	5.34	0.41	4.44	7.73	3.28	130
24	5.46	0.80	4.10	8.81	4.71	100
25	7.59	0.72	5.88	8.87	2.99	20
26	6.18	1.55	4.43	9.84	5.41	18
27	5.54	1.19	3.94	10.05	6.11	29
28	6.12	0.94	3.75	9.91	6.16	108
29	6.10	1.02	4.50	9.13	4.64	118
30	5.78	0.81	3.70	9.23	5.54	88
31	5.77	0.74	4.12	7.46	3.35	63
32	5.03	0.68	3.93	8.93	5.00	104
33	5.93	0.89	4.28	7.66	3.38	25
34	5.43	0.96	3.29	7.74	4.45	51
35	5.25	1.02	4.16	7.59	3.43	12
36	4.40	0.74	3.22	6.52	3.30	46
37	5.59	0.82	3.57	7.95	4.38	104
38	6.02	0.97	3.99	8.35	4.35	106
39	5.47	1.44	3.94	8.89	4.95	9
TOTAL	5.62	1.06	2.84	10.92	8.07	2031

Table 4. (Continued).

(B)

STATION	Mean	Std. Dev.	Minimum	Maximum	Range	n
1	11.67	4.72	6.28	15.07	8.79	3
2	12.86	2.98	10.47	17.20	6.73	4
4	10.48		10.48	10.48	0.00	1
7	9.30	0.79	8.74	9.86	1.12	2
8	9.90	2.79	7.60	16.47	8.87	13
9	12.25	3.97	7.09	19.85	12.76	12
10	11.52	1.73	9.02	16.36	7.35	44
11	10.66	1.30	8.41	13.19	4.78	9
12	9.24		9.24	9.24	0.00	1
13	9.65		9.65	9.65	0.00	1
14	7.68	1.75	6.42	9.67	3.26	3
15	7.22	1.52	5.60	15.72	10.12	55
16	8.18	3.05	5.70	15.11	9.41	20
17	11.50	2.54	9.39	14.31	4.92	3
18	6.96	0.64	5.14	7.99	2.85	106
19	11.13	4.74	7.27	19.37	12.10	7
20	7.56	0.52	6.64	8.75	2.11	20
21	10.56	3.41	6.61	17.35	10.74	16
23	18.37	1.53	16.58	20.17	3.58	4
24	7.15	0.54	5.89	9.77	3.88	104
26	9.40	2.19	7.67	14.68	7.01	9
27	11.49	4.83	6.47	19.51	13.04	9
28	16.74	2.04	14.88	18.82	3.95	4
29	14.02	0.15	13.91	14.12	0.21	2
30	16.26	1.51	15.19	17.32	2.13	2
34	14.05	1.60	11.45	15.79	4.34	8
35	14.77		14.77	14.77	0.00	1
36	12.15	2.06	10.69	13.61	2.92	2
37	17.03	3.53	14.11	23.74	9.63	9
38	15.13	5.05	11.56	18.70	7.14	2
TOTAL	8.90	3.23	5.14	23.74	18.60	476

Figure 1. Map of the west coast of Newfoundland showing the study area and the other locations mentioned in the document.

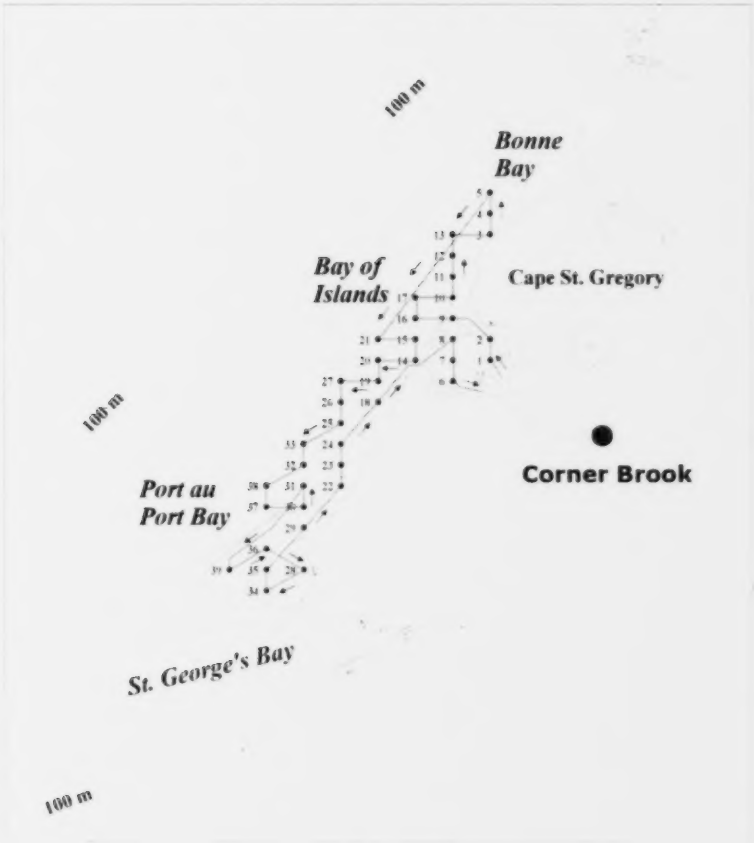


Figure 2. Map of the 39-station sampling grid of the capelin and Atlantic herring larval survey of July 2004.

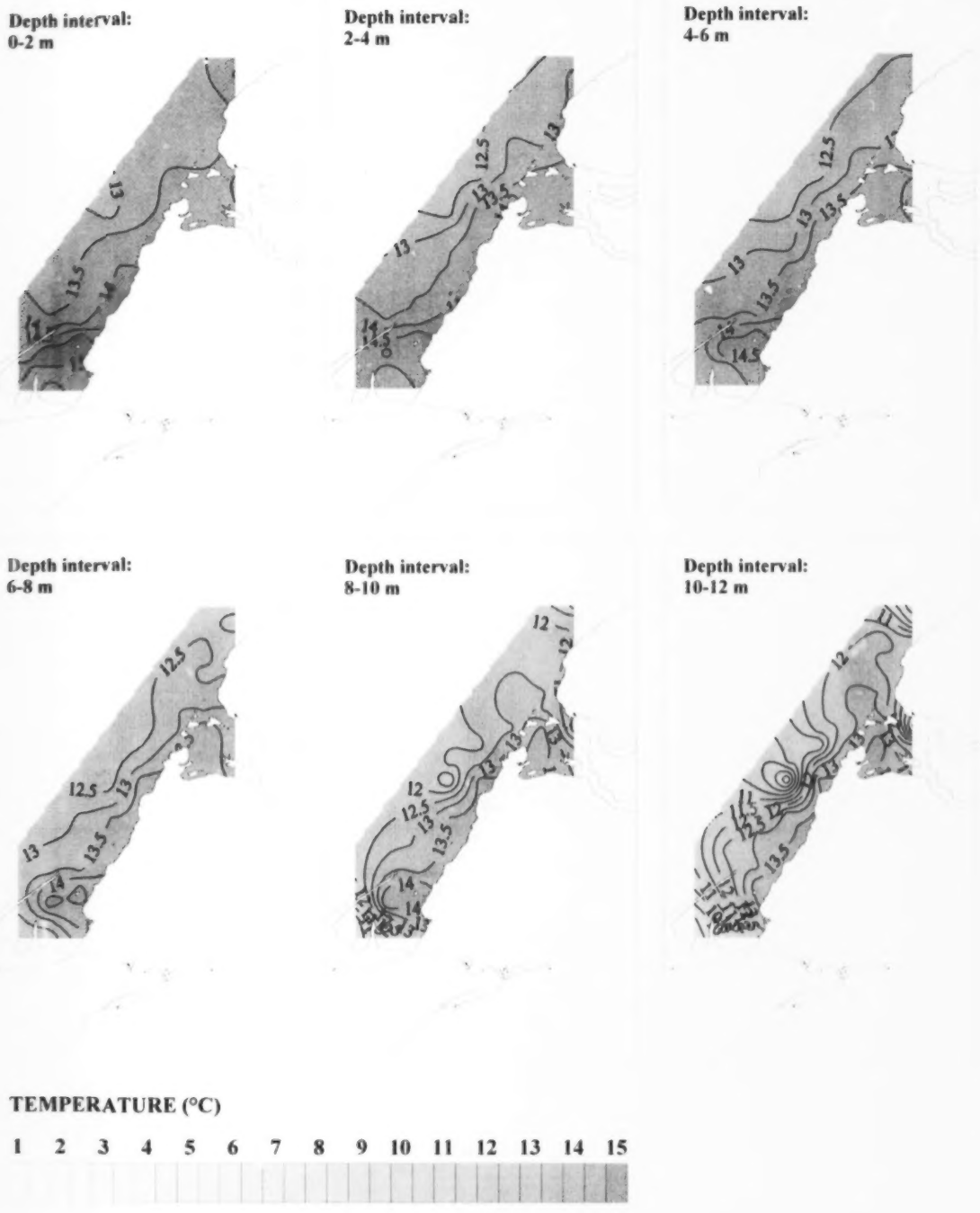


Figure 3. Mean water temperature (°C) by depth intervals of 2 m from 0 m to 20 m and intervals of 5 m between 20 m and 50 m.

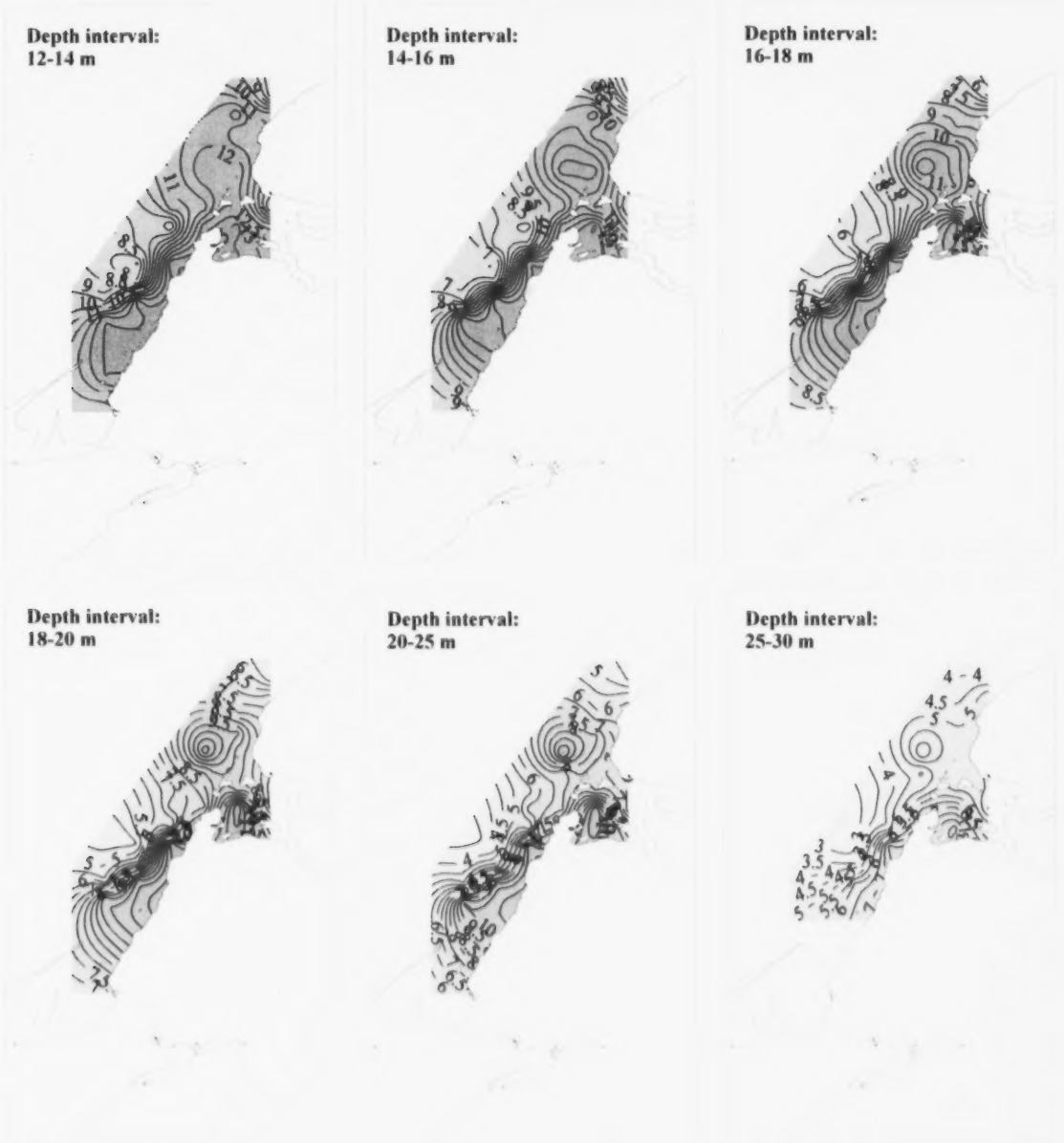
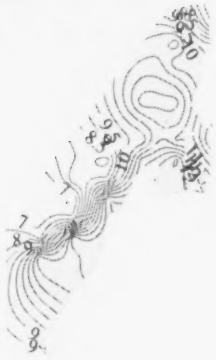


Figure 3. (Continued).

Figure 3. Mean water temperature (°C) by depth intervals of 2 m from 0 m to 20 m and intervals of 5 m between 20 m and 50 m.

Depth interval:
12-14 m

Depth interval:
14-16 m



Depth interval:
16-18 m

Depth interval:
18-20 m

Depth interval:
20-25 m

Depth interval:
25-30 m

TEMPERATURE (°C)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Figure 3. (Continued).

Figure 3. (Continued).

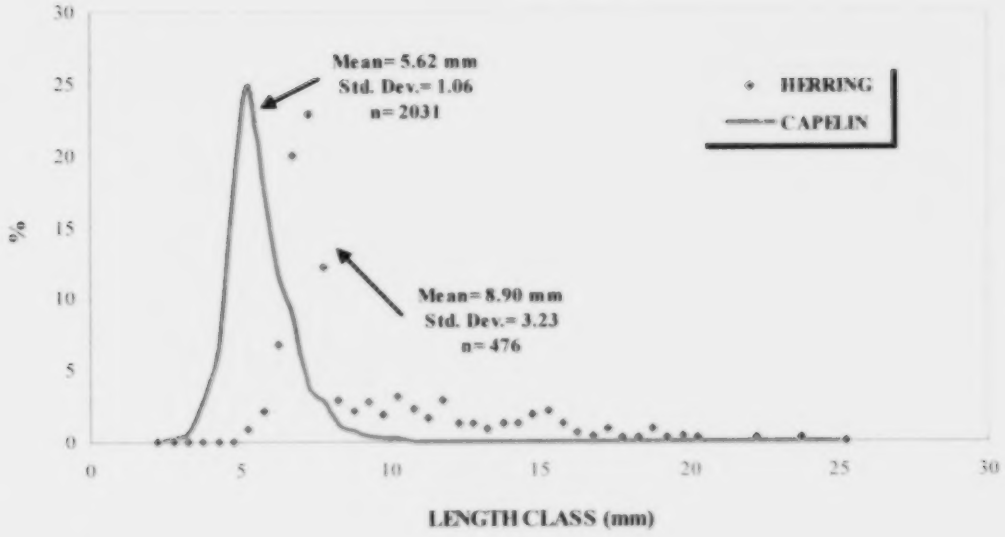
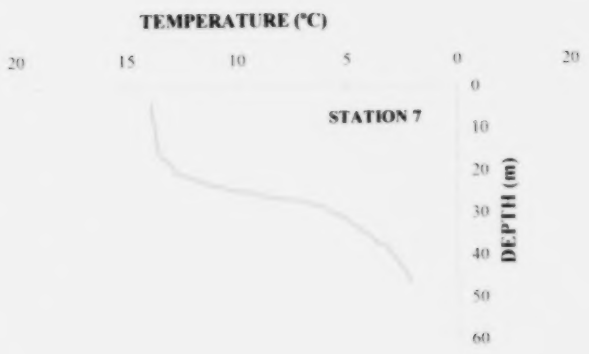
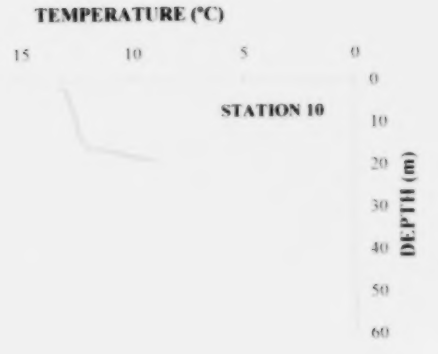


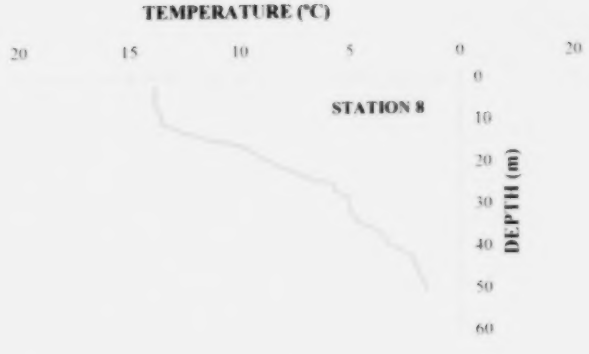
Figure 4. Length (mm) frequency distributions of capelin and Atlantic herring larvae sampled during the July 2004 survey.

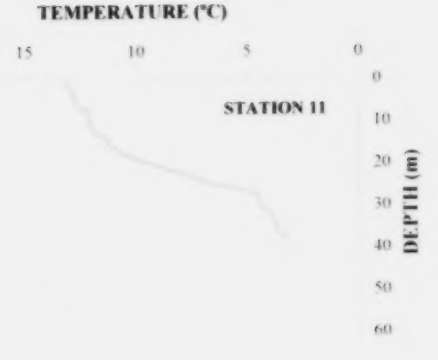
Appendix 1. Temperature profiles for stations sampled during the capelin and Atlantic herring larval survey of July 2004 on the west coast of Newfoundland.

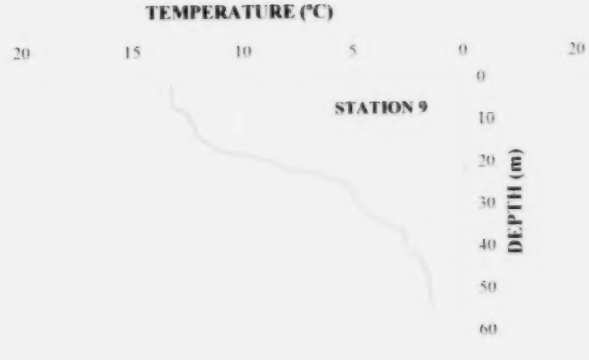
TEMPERATURE (°C)
20
15
10
5
0
STATION 1
STATION 2
STATION 3
STATION 4
STATION 5
STATION 6
DEPTH (m)
0
10
20
30
40
50
60

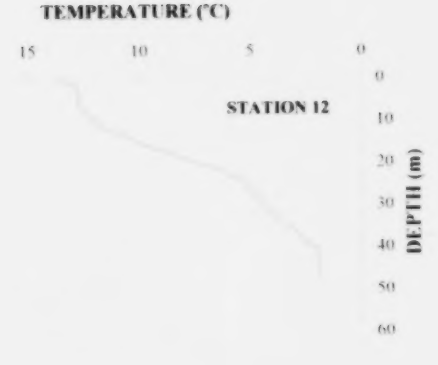

TEMPERATURE (°C)
20
15
10
5
0
STATION 7
0
10
20
30
40
50
60
DEPTH (m)

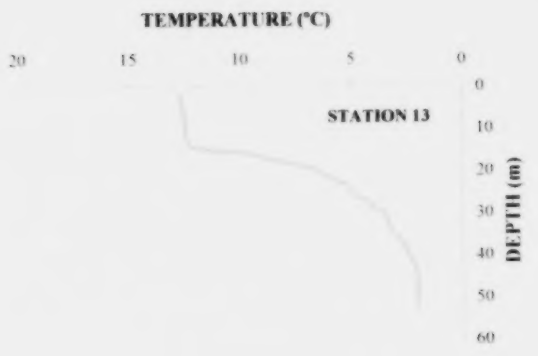

TEMPERATURE (°C)
15
10
5
0
STATION 10
0
10
20
30
40
50
60
DEPTH (m)

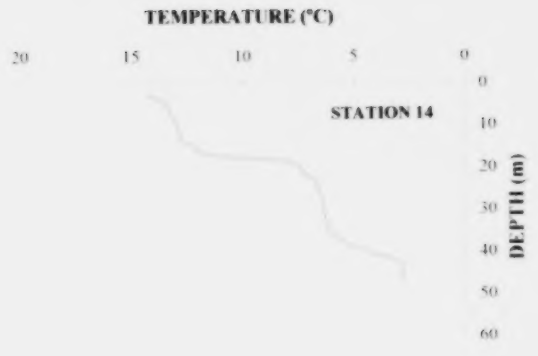

TEMPERATURE (°C)
20
15
10
5
0
STATION 8
0
10
20
30
40
50
60
DEPTH (m)

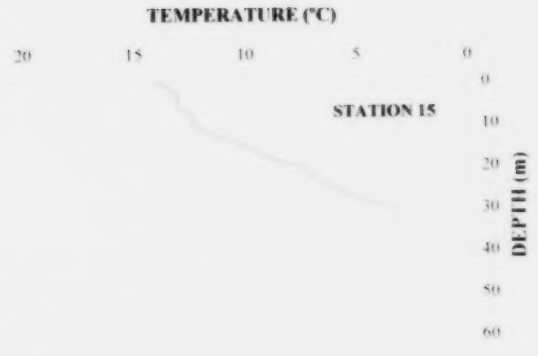

TEMPERATURE (°C)
15
10
5
0
STATION 11
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 9
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
15
10
5
0
STATION 12
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 13
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 14
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
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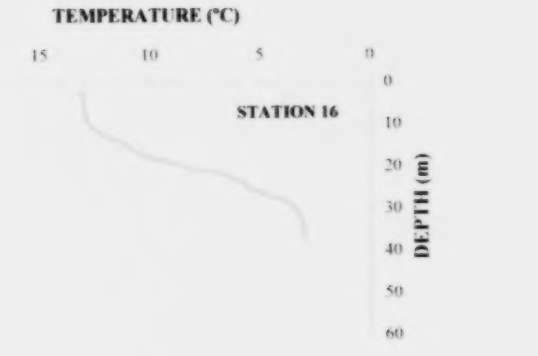
DEPTH (m)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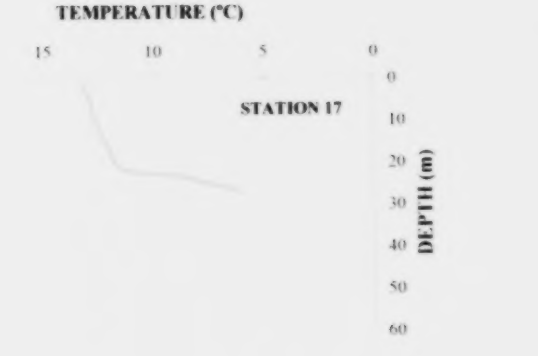
DEPTH (m)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STATION 17
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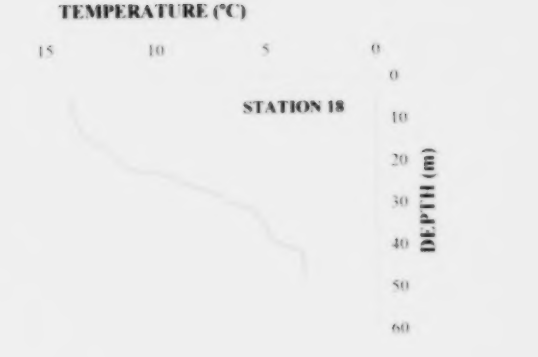
DEPTH (m)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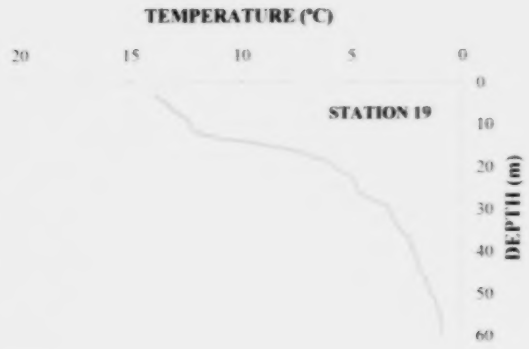
DEPTH (m)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STATION 19
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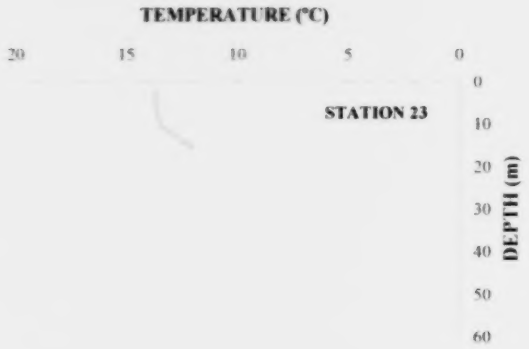
DEPTH (m)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STATION 23
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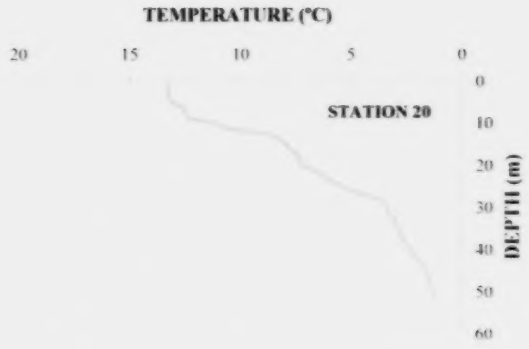
DEPTH (m)


TEMPERATURE (°C)
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STATION 20
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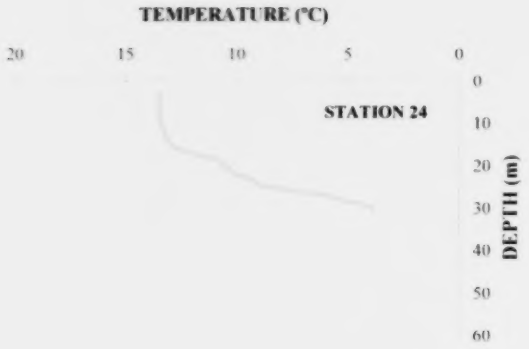
50
60
DEPTH (m)


TEMPERATURE (°C)
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STATION 24
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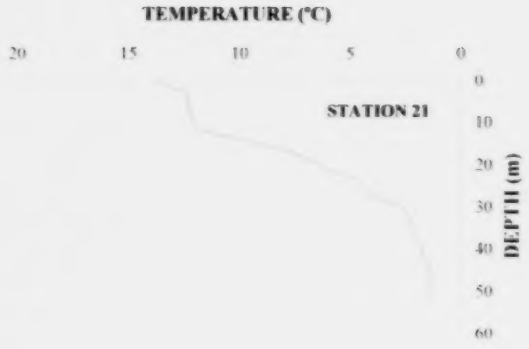
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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15
10
5
0
STATION 21
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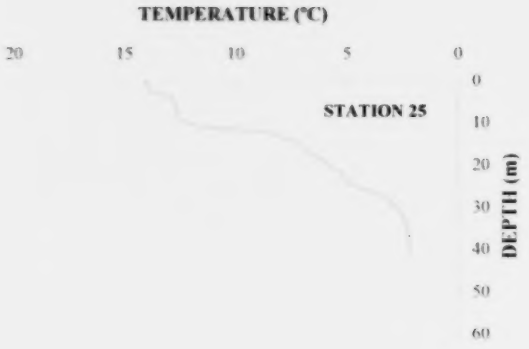
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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5
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STATION 25
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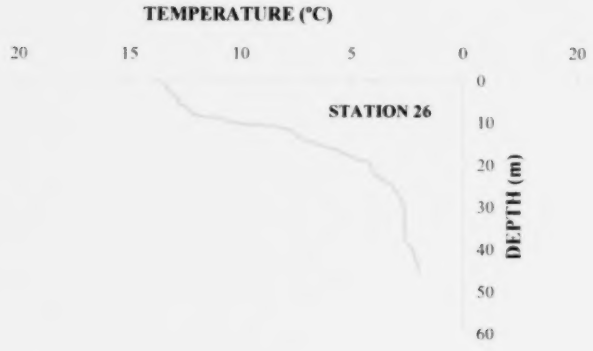
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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5
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STATION 26
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20
30
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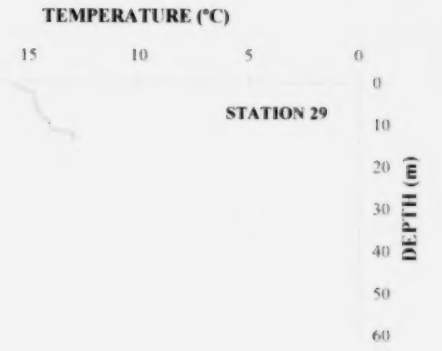
50
60
DEPTH (m)


TEMPERATURE (°C)
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0
STATION 29
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10
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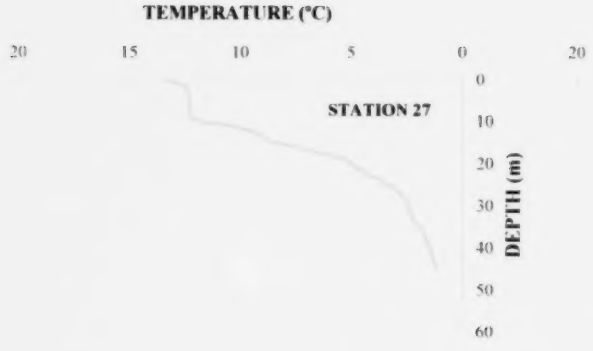
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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15
10
5
0
STATION 27
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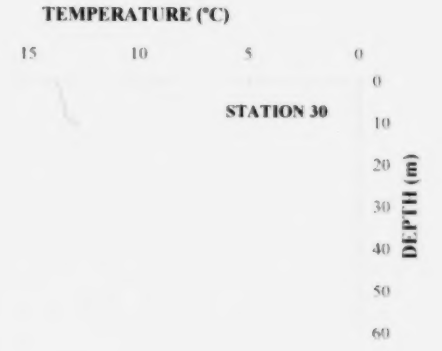
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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5
0
STATION 30
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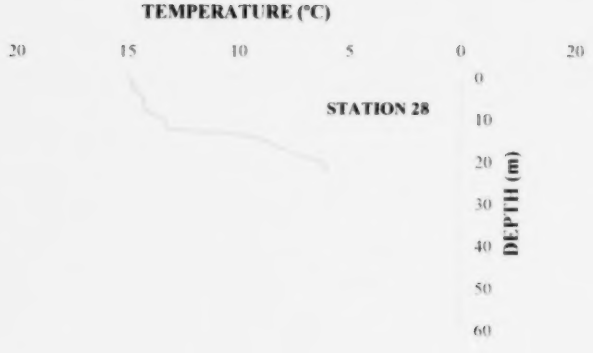
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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5
0
STATION 28
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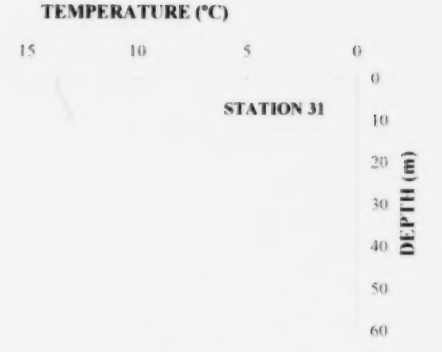
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
15
10
5
0
STATION 31
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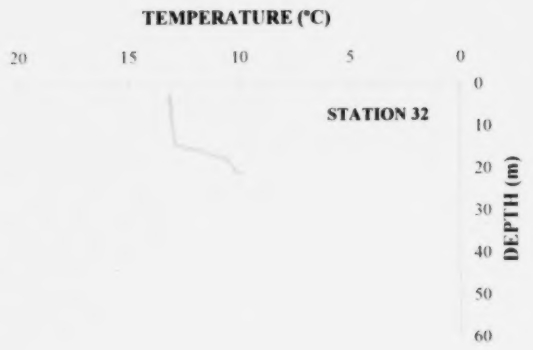
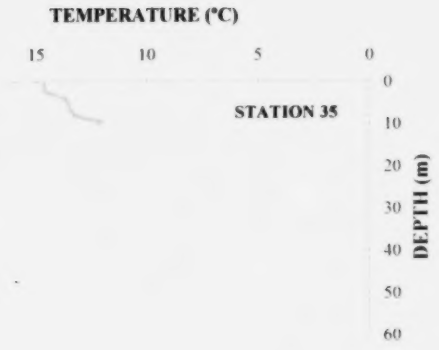
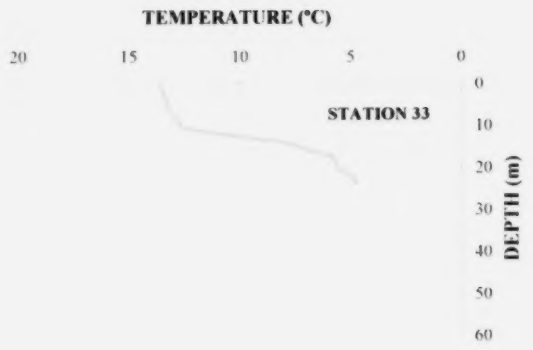
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 32
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 35
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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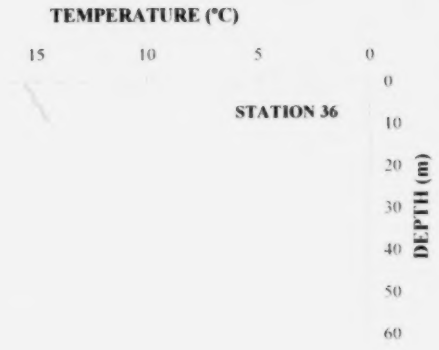
15
10
5
0
STATION 33
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
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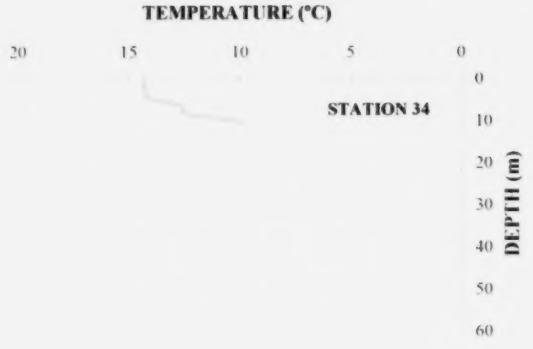
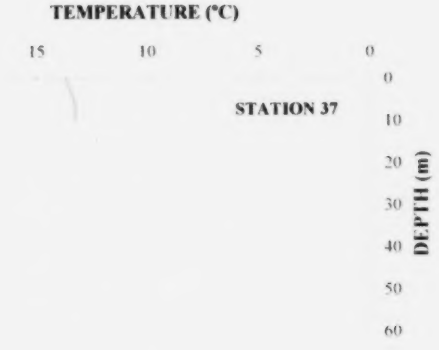
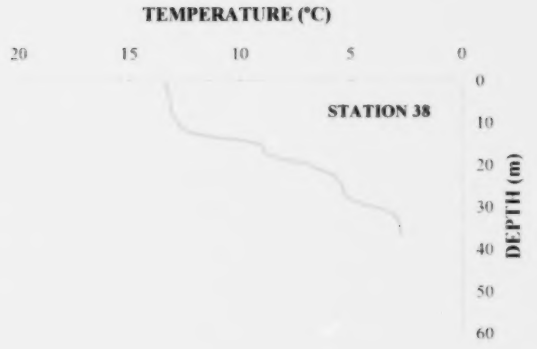
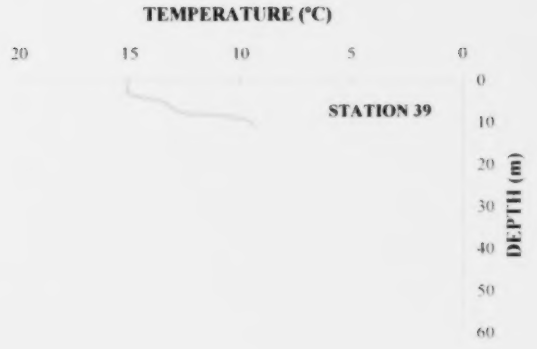
15
10
5
0
STATION 36
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 34
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 37
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 38
0
10
20
30
40
50
60
DEPTH (m)


TEMPERATURE (°C)
20
15
10
5
0
STATION 39
0
10
20
30
40
50
60
DEPTH (m)

Appendix 2. Volume of the plankton sample (ml) and number of eggs sorted and identified from the samples collected during the capelin and Atlantic herring larval survey of July 2004 on the west coast of Newfoundland. Egg codes are as follows: H4B= hake (*Urophycis* sp.), fourbeard rockling (*Enchelyopus cimbrius*), and butterfish (*Peprilus triacanthus*); CHW= cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus)*, and witch flounder (*Glyptocephalus cynoglossus*); CYT= cunner (*Tautogolabrus adspersus*) and yellowtail flounder (*Limanda ferruginea*).

Descriptions and pictures of mackerel eggs are found in Girard (2000).

STATION	SAMPLE VOLUME (ml)	EGGS (n)									
		MACKEREL					H4B	CHW	CYT	American plaice *(Hippoglossoides platessoides)*	Windowpane *(Scophthalmus aquosus)*
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5					
1	24	6	6	4	0	0	0	72	856	16	8
2	25	7	0	2	0	0	0	48	536	0	0
3	*	9	0	0	0	0	16	272	360	0	0
4	120	78	0	0	0	0	0	376	16	0	0
5	70	6	0	0	0	1	0	272	0	0	0
6	50	6	0	0	2	0	8	120	656	8	0
7	60	22	3	4	3	0	32	32	2800	6	0
8	60	11	8	4	2	1	0	96	816	8	0
9	75	3	2	8	3	0	8	112	1104	0	0
10	50	20	0	0	0	0	8	128	1192	3	0
11	100	29	0	0	0	1	0	256	48	0	0
12	60	32	0	0	0	0	0	256	8	0	0
13	59	8	0	0	0	0	0	224	0	0	0
14	115	9	7	1	1	0	8	80	984	8	0
15	160	2	0	0	0	0	0	256	312	8	0
16	75	10	4	1	0	0	8	96	1176	3	0
17	65	21	0	2	1	4	0	168	160	8	0
18	110	31	4	6	5	1	6	82	3360	0	0
19	110	4	2	0	0	0	0	168	704	0	0
20	120	2	5	1	1	0	0	488	184	0	0
21	160	21	0	0	0	1	0	432	0	8	0
22	40	6	0	4	0	1	0	40	664	8	0
23	50	30	4	4	0	1	128	20	6016	0	4
24	45	44	0	1	1	0	0	96	4608	0	8
25	130	0	0	0	0	0	0	64	8	0	0
26	135	1	0	0	0	1	0	352	16	0	0
27	150	1	1	0	0	1	0	808	8	8	0
28	55	27	0	0	0	0	360	48	488	0	0

* Missing data

STATION	SAMPLE VOLUME (ml)	EGGS (n)									
		MACKEREL					H4B	CHW	CYT	American plaice *(Hippoglossoides platessoides)*	Windowpane *(Scophthalmus aquosus)*
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5					
29	40	4	2	8	4	1	896	0	8320	0	0
30	50	38	7	6	0	1	48	104	3872	0	0
31	60	8	1	1	0	0	48	96	2360	0	32
32	30	11	0	0	0	0	0	64	72	0	0
33	35	0	0	0	0	0	0	96	0	0	0
34	50	10	0	1	0	0	128	40	136	0	0
35	30	1	0	0	0	0	24	0	7968	0	8
36	50	10	5	3	0	0	816	0	3416	0	8
37	30	42	11	5	1	2	16	64	6888	0	0
38	120	0	0	0	0	0	0	96	24	0	0
39	70	0	0	0	0	0	72	0	112	0	16

Appendix 3. Number of larvae sorted and identified from the samples collected during the capelin and Atlantic herring larval survey of July 2004 on the west coast of Newfoundland. Scientific names are as follows: mackerel (*Scomber scombrus*), sand lance (*Ammodytes* sp.), herring (*Clupea harengus harengus*), cod (*Gadus morhua*), American plaice (*Hippoglossoides platessoides*), snailfish (*Liparis* sp.), Stichaeidae (*Lumpenus* sp.), capelin (*Mallotus villosus*), redfish (*Sebastes* sp.), arctic shanny (*Stichaeus punctatus*), radiated shanny (*Ulvaria subbifurcata*), fourbeard rockling (*Enchelyopus cimbrius*), witch flounder (*Glyptocephalus cynoglossus*), yellowtail flounder (*Limanda ferruginea*), winter flounder (*Pseudopleuronectes americanus*), righteye flounder (Pleuronectidae spp.), sculpins (*Myoxocephalus* sp.), cunner (*Tautogolabrus adspersus*), windowpane flounder (*Scophthalmus aquosus*), poachers (*Agonidae* sp.), broken larvae, other larvae not identified.

STATION	Mackerel	Sand Lance	Herring	Cod	American plaice	Snailfish	Stichaeidae	Capelin	Redfish	Arctic shanny	Radiated shanny	Fourbeard rockling	Witch flounder	Yellowtail flounder
1	1	1	4	3	0	4	0	15	1	0	0	2	0	0
2	2	1	4	5	0	8	0	808	0	0	3	4	0	0
3	0	0	0	2	0	0	0	76	0	0	1	3	0	0
4	0	4	1	12	0	0	0	6	1	0	2	9	0	0
5	0	1	0	6	0	5	0	15	0	0	0	2	0	0
6	3	0	0	2	0	0	0	94	0	0	1	4	0	0
7	1	0	1	8	0	9	0	72	0	0	0	1	0	0
8	0	0	15	16	0	8	0	1568	0	0	0	2	0	0
9	0	0	14	4	0	3	0	106	0	1	0	1	0	0
10	1	1	47	0	0	0	0	14	0	0	13	9	2	1
11	0	2	9	9	0	0	0	3	0	0	1	0	2	0
12	0	2	1	26	0	9	0	10	0	0	5	1	0	0
13	2	1	1	5	0	1	1	0	0	0	0	2	0	0
14	1	0	3	4	0	18	0	36	0	0	3	1	0	0
15	1	1	56	34	0	1	0	110	0	1	3	1	1	0
16	0	1	38	12	0	2	0	82	0	0	8	4	0	0
17	0	1	3	19	0	0	0	9	0	3	3	2	0	0
18	5	0	1840	21	0	2	0	920	0	1	5	1	0	0
19	1	0	7	17	0	2	0	17	1	0	3	1	0	0
20	2	0	22	52	0	3	0	54	0	0	1	2	0	0
21	0	1	18	26	0	9	0	10	0	0	4	2	0	0
22	0	0	0	0	0	1	0	112	0	0	0	3	0	0
23	10	0	4	3	0	0	0	2144	0	0	14	0	0	0
24	0	0	196	10	0	4	0	512	0	0	2	0	0	0
25	0	0	0	40	0	6	0	42	0	0	10	0	0	0
26	1	0	10	21	0	5	0	20	0	0	2	1	0	0
27	1	1	9	38	0	1	0	37	1	0	3	1	0	0
28	1	0	4	1	0	0	0	108	0	0	3	5	0	0

STATION	Winter flounder	Righteye flounder	Sculpins	Cunner	Windowpane flounder	Poachers	Broken larvae	Other larvae not identified
1	7	1	0	0	0	0	0	0
2	0	3	0	41	0	0	0	0
3	0	7	0	4	0	0	0	0
4	2	20	0	0	0	0	0	0
5	0	20	1	0	0	0	1	0
6	4	9	0	184	0	0	0	0
7	6	5	0	320	1	0	0	0
8	4	3	0	208	0	0	0	0
9	10	3	0	7	0	0	0	4
10	0	0	0	4	0	0	1	0
11	2	2	0	1	0	0	0	0
12	2	5	0	1	0	0	0	0
13	1	2	0	0	0	0	0	0
14	0	7	0	2	0	0	3	0
15	0	31	0	6	2	0	0	0
16	10	3	0	4	0	0	5	0
17	1	16	0	5	0	0	0	0
18	9	17	0	37	0	0	5	0
19	0	34	0	2	0	0	1	0
20	0	36	0	1	0	1	2	0
21	0	16	0	0	0	0	0	0
22	1	6	0	28	0	0	0	0
23	2	40	0	238	4	0	0	0
24	0	42	0	48	2	0	0	0
25	0	54	0	2	0	0	0	0
26	1	28	0	3	1	0	1	0
27	0	39	0	1	1	0	3	0
28	0	2	0	49	1	0	0	1

STATION	Mackerel	Sand Lance	Herring	Cod	American plaice	Snailfish	Stichaeidae	Capelin	Redfish	Arctic shanny	Radiated shanny	Fourbeard rockling	Witch flounder	Yellowtail flounder
29	7	0	0	0	0	0	0	129	0	0	6	24	0	0
30	9	0	2	0	0	1	0	91	0	0	21	2	0	0
31	4	0	0	2	0	1	0	63	0	0	9	0	0	0
32	0	0	0	0	0	0	0	450	0	0	0	0	0	0
33	0	0	0	30	0	0	0	58	0	0	12	0	0	0
34	0	0	8	0	1	0	0	54	0	0	1	2	0	0
35	0	0	1	0	0	0	0	13	0	0	0	7	0	0
36	1	0	2	0	0	0	0	50	0	0	5	5	0	0
37	32	0	9	5	0	0	0	174	0	0	8	2	0	0
38	2	0	2	40	0	3	0	205	0	0	10	0	0	0
39	0	0	0	0	0	0	0	9	0	0	0	1	0	0

STATION	Winter flounder	Righteye flounder	Sculpins	Cunner	Windowpane flounder	Poachers	Broken larvae	Other larvae not identified
29	16	2	0	1440	0	0	0	0
30	4	13	0	3	3	0	1	0
31	14	5	0	27	1	0	1	0
32	0	14	0	2	0	0	0	2
33	0	36	0	0	0	0	0	0
34	1	2	0	32	1	0	0	0
35	1	0	0	34	0	0	0	0
36	1	1	0	68	0	0	1	0
37	24	2	0	47	4	0	1	0
38	23	21	0	23	0	0	0	1
39	0	0	0	4	0	0	0	0